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COYOTE-PROOF PASTURE EXPERIMENT, 1908.

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COYOTE-PROOF PASTURE EXPERIMENT, 1908.

INTRODUCTION.

This report contains the results of the experiments with sheep in connection with a coyote-proof pasture at Billy Meadows, on the Wallowa National Forest, in Oregon, the purpose of which was to determine the efficiency of the pasturage system of handling sheep, with a view to the best utilization of grazing lands. The work was planned and carried out with the cooperation of the Bureau of Plant Industry. A preliminary report of the work, which gave the progress made during 1907, was published as Circular 156 of the Forest Service. In it were discussed: The selection of the pasture area; the construction of the coyote-proof fence and the attitude of predatory animals toward it; the actions of a dry band of Merino sheep when at liberty in the inclosure; and the effects of such a grazing system upon the forage crop. The selection of the area and the specifications for the fence, as well as the work of construction, were presented in detail. With regard to the fence itself, it will be necessary to mention here only its durability and the cost of maintenance. The attitude of predatory animals toward the fence, the actions of the sheep at liberty in the inclosure, and the effects and advantages of such a grazing system can be established only by investigations covering more than one year.

This report, then, which carries the experiments through 1908, will discuss: The durability of the coyote-proof fence and the cost of maintaining it; the attitude of predatory animals toward the fence; the actions of a band of merino ewes and lambs when at liberty in the inclosure; and the effects of such a grazing system upon the sheep and the carrying capacity of grazing lands.

REPAIRING THE FENCE.

Approximately 5 of the 8 miles of fence line extends through forest, which varies from open stands of yellow pine to dense lodgepole thickets. The great loads of wet snow in winter and occasional heavy winds in early spring throw a number of trees each year. It was thought that wherever a tree struck the fence line the wires would be broken or crushed to the ground. An examination of the area on April 16, 1908, showed that part of the fence was still under

3 feet of snow and that 38 trees had fallen across the wire. For the most part they were "bug-killed" lodgepole, varying from 6 inches to 16 inches in diameter.

In a few places, where heavy trees struck the wire near a post, the barbed wires and from one to four strands of the woven wire were broken. In such instances the post and staples acted as cutting edges against the force of the tree. Where a tree fell midway between posts, the barbed wires usually were broken and the woven wire bent or crushed together. The woven wire was broken only in 4 places and the barbed wires in about 30 places on the 8 miles of line. The work of repairing was simple and rapid. The trees were sawed into blocks and removed. The woven wire was then straightened and the kinks removed by two men working with a small pole. The sag was taken up and the wire made stationary by small pole stays. Where necessary, extra barbed wire was inserted until there was no space of greater width than 6 inches remaining immediately above the woven wire. No extra woven wire was necessary in any case.

The work of removing trees and repairing the breaks required two days' labor for two men—a cost of $10.

Aside from the damage done by falling trees there were many small holes made by the spring "run-off" in rivulets and canyons. To repair these required two days' labor for two men—a cost of $10.

The 700 rock "jacks" constructed on scab rock areas to take the place of posts set in the ground proved to be very satisfactory, both as to stability and durability. They will last much longer than posts set in the ground, and, where properly constructed, are just as stable. The increase in first cost over posts set in the ground will be more than offset by the durability of the "jack."

When the experiment was closed, on October 1, 1908, the fence was in excellent condition. The wire was well in place and taut everywhere, and the bottom of the fence was free from holes.

The cost of maintenance of the 8 miles for the first year was $20.

ATTITUDE OF ANIMALS TOWARD THE FENCE, APRIL 20 TO JUNE 21.

The great number of predatory animals that each year prey upon bands of sheep which summer in the vicinity of the experimental pasture made it necessary to employ a hunter during the months of April, May, and June, until the detail work of the pasture experiment should begin.

Mr. J. K. Carper, who had acted as hunter at the pasture during the season of 1907, was again employed, assuming his duties as forest guard and hunter April 20, 1908. Mr. Carper hunted in the vicinity of the coyote-proof pasture until June 21, when he began his detail work of daily patrolling the 8 miles of fence line inclosing the experimental area.

BEARS.

More bears came in contact with the fence during this period than during the experimental work. Hardly a day passed without evidence of one or more having been in or near the pasture. Their apparent disregard for the coyote-proof fence and the frequency of their passage through it showed beyond doubt that the fence will not keep out black, brown, or grizzly bears. Three brown bears were killed in or near the inclosure between April 28 and May 2. One was killed later, before June 21.

COYOTES.

There were very few coyotes near the area before June 20. When the sheep and cattle are removed to the winter quarters the coyotes follow, to return when the stock is brought back to the summer range. This fact was taken advantage of at the pasture, and by repairing the fence before May 10 it was proof against coyotes when they returned from their winter haunts. The coyote that gave so much trouble inside the pasture during 1907 remained there until the heavy winter storms piled snow to the top of the fence, enabling him to pass out. While coyotes were present constantly outside the pasture during the experimental period, the fence removed them as a source of trouble.

PATROL.

When the sheep were turned loose on June 21, the hunter began his patrol work (fig. 1). The fence line was inspected each day and a record made of the attitude toward the fence of every animal that came to it between June 21 and September 25. This was done to protect the sheep against the bears that might enter at any time, especially during the night; and further, to show, at the close of the season, how many animals came to the fence, and its efficiency as a protection against them.

For this work Mr. Carper was provided with two foxhounds, two dogs of mixed bloodhound and bulldog, and one mixed foxhound, bloodhound, and bulldog. All except the favorite foxhound were killed or lost during the season.

It was necessary to begin the tour of the 8 miles of fence at dawn each morning, in order that the circuit could be made before the sun dried the dew and removed the scent from the ground, grass, or trees. The track of any animal that had been to the fence during the night could be taken up by the foxhound the next morning, provided he reached it before a hot sun removed the scent. A track made at 10 o'clock on a hot, dry day often could not be followed two hours later. When the hounds struck a track, the hunter followed to find

out what animal had made it, what had been its attitude toward the fence and, if possible, to kill it. When a bear track was scented, it was necessary to give chase. This fact resulted, without doubt, in

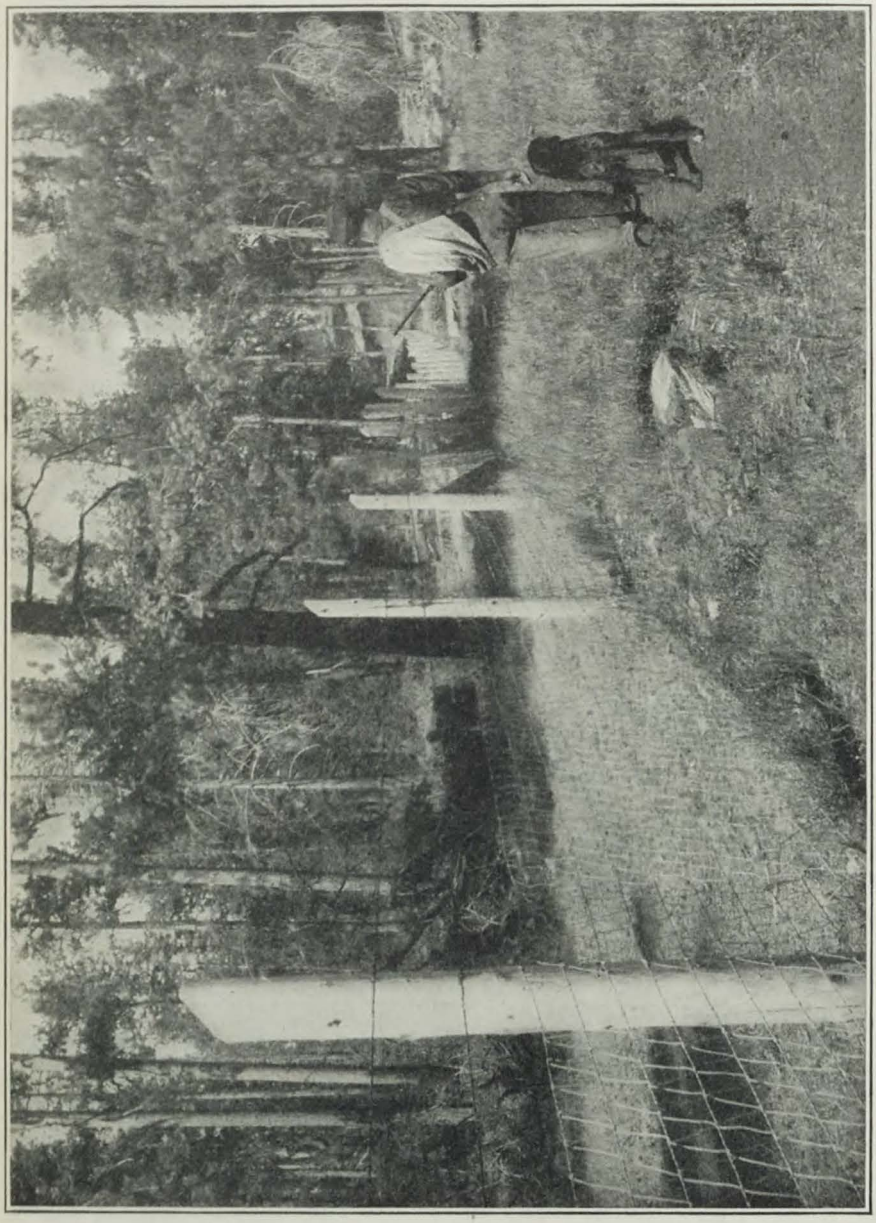

FIG. 1.—Coyote-proof fence and hunter and hound patrolling it.

losing the record of many coyotes that had been to the fence. However, sufficient numbers were recorded to make it certain that they were constantly in the neighborhood.

Table 1 was compiled from the daily reports of the hunter and shows the number and kind of animals observed, the attitude of each toward the coyote-proof fence, and the number killed.

To aid those who are not familiar with the coyote-proof fence the specifications are repeated:

Posts set 2½ feet in the ground and 16 feet apart; on the surface of the ground a barbed wire; 3 inches higher a 42-inch woven "Elwood lawn fence," with a 4-inch triangular mesh; 6 inches higher a barbed wire; 8 inches above this a second barbed wire. Total height 59 inches. Figure 1 shows the coyote-proof fence and the hunter and hound patrolling it.

TABLE 1.—*Efficiency of the fence.*

Animal.	Period.	Came to fence.	Got through fence.	Turned away.	Killed by hunter.
Coyote	June 21–Sept. 25	136	0	136	9
Grizzly bear	Apr. 20–Sept. 25	8	7	[a] 1	2
Brown bear	do	9	8	0	5
Bobcat	do	4	[b] 1	[c] 3	3
Lynx	June 21–Sept. 25	3	3	0	0
Badger	do	2	2	0	2
Elk	do	1	1	0	0

[a] No attempt made to go through.
[b] Went in and out on tree across fence.
[c] No evidence of attempts to go through.

The data given in Table 1 may be supplemented as follows:

Number and kind of animals observed—Some animal was at the fence line seventy-nine out of the ninety-five days of record. Those observed were coyotes, grizzly bears, black bears, brown bears, bobcats, lynxes, badgers, and elk. Coyotes were present seventy-two out of ninety-five days.

Time of appearance—All animals observed appeared during the night or early morning. At some time or other animals came to every point of the fence line.

ATTITUDE TOWARD FENCE.

COYOTES.

Little comment is necessary on the results just given. Coyotes came to the fence nearly every night for ninety-five days and occasionally they followed it for several miles. Not one has passed through, over, or under the fence since its construction, except over the snow. Residents of sections where coyotes are very numerous, and where some attempt has been made to fence against them, have testified that they have seen coyotes jump fences 5 feet or more in height. They have not done so at the coyote-proof pasture. It is

possible, however, that in settled sections where coyotes are constantly coming in contact with barbed-wire fences they may become accustomed to them and jump them.

GRIZZLY BEARS.

All the grizzly bears that passed through the fence did so by going through the 6-inch space between the woven wire and the first barbed wire above, or through the 8-inch space between the two top barbed wires. The woven wire was pushed inward or outward and the barbed wire upward; the claws of the hind feet were hooked into the meshes of the woven wire, giving the bear a pull to force his body through. Usually he left a space of from 16 inches to 24 inches. So far as noted, whenever the fence crossed the path of the grizzly bear he went through it. Apparently there was no desire and no need to search for a weak place.

OTHER BEARS.

The data of 1907 left some doubt as to whether black or brown bears would go through the fence. That doubt no longer exists, since all kinds of bears went through the fence. One large brown bear was killed within the inclosure, and on many occasions the fur left on the barbed wire furnished conclusive evidence as to the kinds of bears that had entered. Black and brown bears make their attacks upon the fence in the same way as grizzlies, and with the same effect.

BOBCATS.

The limited data on the actions of bobcats make it still impossible to draw any definite conclusions. Only four cats were reported upon by the hunter. Three of them were killed. On May 9 one bobcat passed in and out of the pasture over a tree that had fallen across the fence during a snowstorm on that date. The tracks remained in the snow on the tree, and the trail was followed by the hounds and the cat killed. Three other cats came to the fence several times, but apparently made no attempt to get through.

LYNXES.

On three occasions the hunter reported that a lynx, apparently the Canada lynx, had been to the pasture. The first observation showed some evidence of the animal having gone through the fence between the two top barbed wires. In leaving the area on this occasion and in going in and out on a later date he apparently left no trace of the way he got through. It is possible that he passed between the wires, as a dog might do, and left no trace. It can be said only that, so far as observed, this animal went through or over the fence whenever he

came to it. An interesting feature in connection with this animal was that on at least three occasions the hounds trailed him, on a hot trail, for about 5 miles, and could not tree him. Four out of the five bobcats killed were treed within one-half mile after being "jumped" by the hounds.

BADGERS.

Two badgers dug under the fence. This must be expected. The damage from this source can be met only by filling the holes before coyotes pass through them into the area.

ELK.

On August 26 a large elk passed through the pasture. As nearly as could be ascertained, he came to the fence on the run and "smashed" into it at an angle of about 45°, apparently not having seen the wires. Both top barbed wires were broken and thrown back and the woven wire was collapsed. About 6 feet of the barbed wires showed evidence of having ripped through flesh and hide. The track was followed through the pasture to the opposite side, where the animal had walked to the fence and made a clear jump over the wires. He could readily be trailed by the blood stains left on rocks, logs, and trees.

SUMMARY.

In conclusion, it may be said that during the season of 1908 the coyote-proof fence was entirely successful as a protection against coyotes; not successful against bear; still problematic against bobcats; not successful against lynxes, and, of course, not successful against badgers.

The depredations of bears, bobcats, and lynxes are confined to comparatively few areas. Even on grazing lands where they are most numerous the losses caused by them are small as compared to the great losses due to coyotes. The coyote is the one great menace to the sheep industry, and in excluding him the fence has served the purpose for which it was designed.

ACTIONS OF A BAND OF SHEEP AT LIBERTY IN THE INCLOSURE.

During the short period of test in 1907 a band of dry sheep, old ewes and yearlings of Merino breed, were at liberty in the pasture. In 1908 it was decided to study the actions of a band of Merino and Rambouillet ewes with their lambs.

COOPERATION WITH SHEEPMEN.

An agreement similar to that which existed between the sheepmen and the Forest Service in 1907 was entered into by Mr. J. H. Dobbin,

a sheep owner, of Joseph, Oreg., and the Forest Service. This agreement provided that:

(1) The Forest Service should furnish: (*a*) The pasture inclosed in 1907; (*b*) a man to superintend the experiment; (*c*) a hunter to

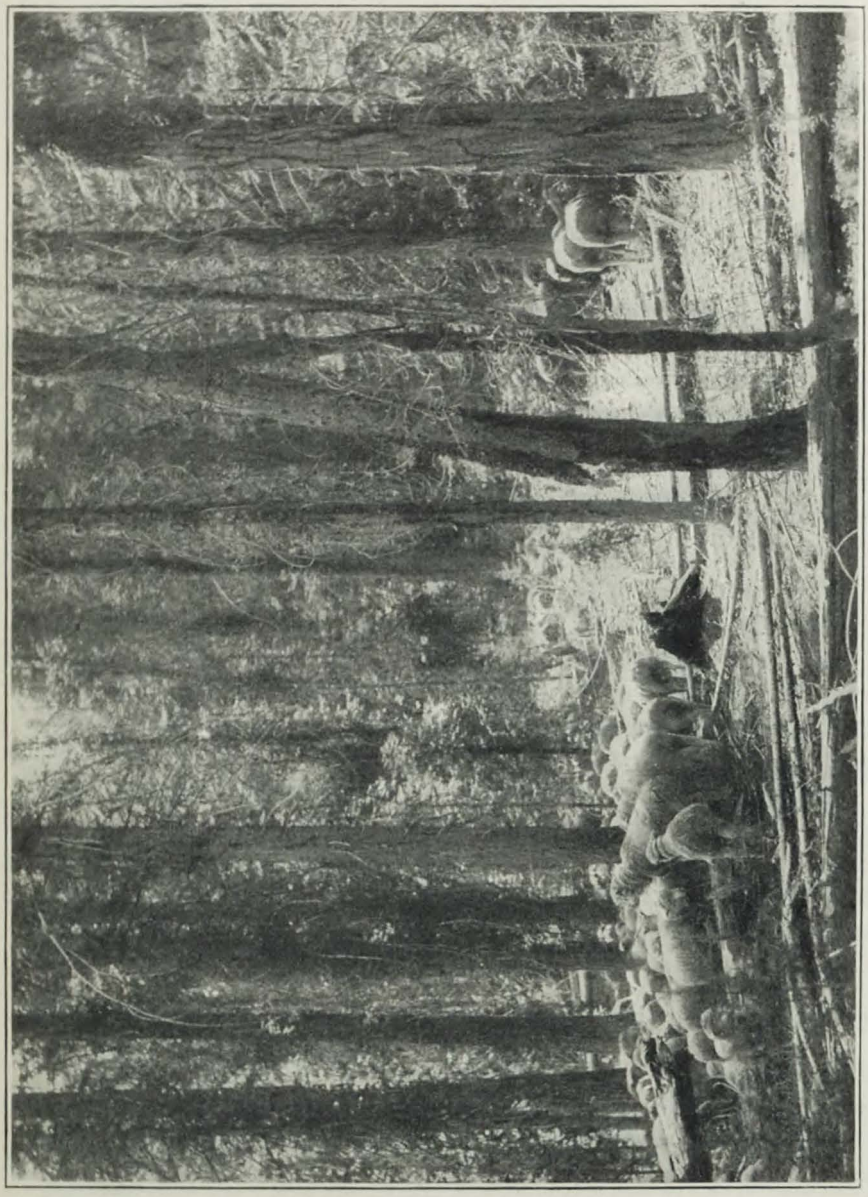

FIG. 2.—Pastured sheep on grazing area in heavy timber.

clear the area of wild animals and patrol it during the experimental period.

(2) The owner should furnish: (*a*) A band of ewes and lambs; (*b*) a sheep tender.

(3) The sheep should not be disturbed except by the direction of the officer superintending the experiment.

(4) The Forest Service should not be responsible for injury to or losses among the sheep.

THE SHEEP.

The band consisted of 1,200 ewes and their increase, 1,009 lambs. The ewes were a good class of mixed Merino and Rambouillet breed, from 5 to 8 years old. The lambs were sired by Rambouillet rams. The band was lambed on the early range, between March 20 and April 20. Most of the lambs came in April. The ewes were sheared in early June, and were turned loose in the pasture on June 21.

PASTURE AREA.

In considering the actions of the sheep, it is essential to bear in mind that the inclosed area consisted of 2,560 acres, in the form of a square, 2 miles on a side, made up of 1,300 acres of heavy timber (fig. 2), 400 acres of open timber (fig. 3), and 860 acres of glade range (fig. 4).

OBSERVATIONS MADE.

Observations were made daily from June 21 until September 25. So far as possible, without molesting the sheep, the entire band was kept track of from the moment they left the bed ground in the morning until they bedded at night. The data obtained will be discussed as in Circular No. 156, under the following points:

(1) Do sheep separate into small bunches when allowed to graze at random, unmolested by animals?

(2) To what extent do sheep scatter and graze openly if allowed perfect freedom?

(3) Do sheep bed together in large bands when allowed this freedom?

(4) Under these conditions, to what extent do sheep seek the same bed ground night after night?

An attempt has been made to place the daily observations in tabulated form. This will allow the reader to draw his own conclusions, as well as serve as a basis for the conclusions and discussion presented here.

On September 25, at the end of the season, the sheep used in the experiment were counted and turned over to the owner. The count showed a total of 2,194 sheep, a loss of 15 since June 21, when the animals were turned into the pasture. Five of the sheep were lost through poisonous plants, 3 from timber snags, 2 from bruises in shearing, and 1 from "flyblow;" 3 were killed for mutton; and 1 was unaccounted for.

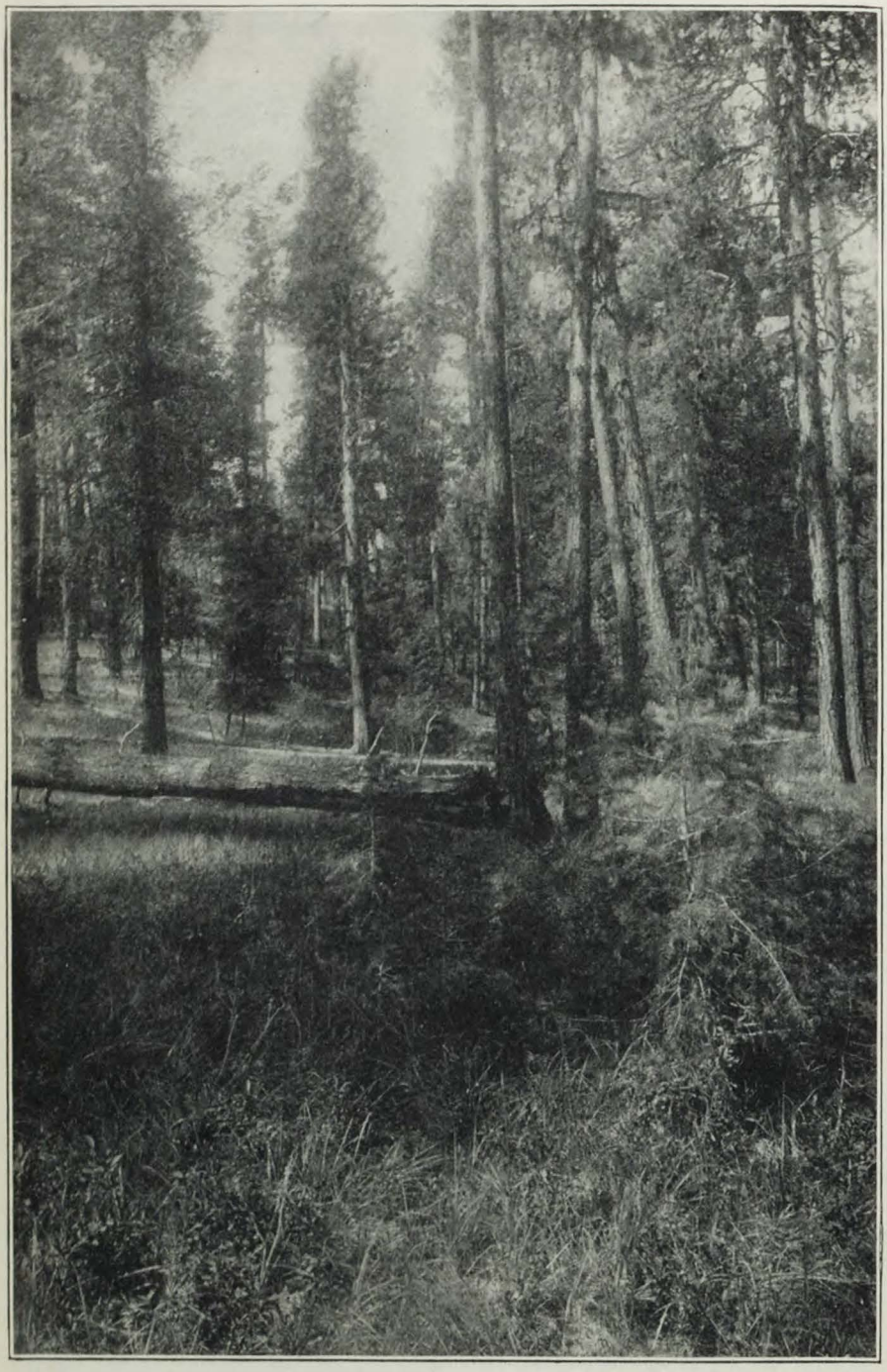

FIG. 3.—View in open yellow pine range in pasture.

FIG. 4.—Open grazing in a glade area.

TABLE 2.—*Actions of 2,209 ewes and lambs at liberty within coyote-proof inclosure.*

Date.	Time of day.	Number of bunches.	Approximate number of sheep in each bunch.	How grazing.	Approximate distance grazed.	Where bedding.	Remarks.
June 21	5 p. m.	1	2,209	Openly			Ewes and lambs turned loose in pasture, 2,209.
	7.30 p. m.	1	2,209	Bedded		Bed No. 1	Near sheep tender's tent.
22	4.30 a. m.	1	2,209	Leaving bed ground			
	11 a. m.	1	2,209	Open grazing	½ mile		Very widely scattered.
	7.30	1	2,209	Bedding	¾ mile	Bed No. 2	Grazed openly all day.
23	4.30 a. m.	1	2,209	Leaving bed ground			
	In one band all day.		2,209	Open grazing	¾ mile	Bed No. 1	
24	do			do	1 mile	do	Grazed openly in one band all day.
25	do			do	1½ miles	do	Grazed openly but moved too much.
26	4.30 a. m.	1	2,209	Leaving bed ground			
	8 a. m.	2	1,500–700	Open grazing	¼ mile		
	6 p. m.	2	1,500–700	do	1½ miles		
	7.30 p. m.	1	2,209	Bedding	1⅝ miles	Bed No. 1	Came together on bed ground.
27	4 a. m.	1	2,209	Leaving bed ground			
	3 p. m.	1	2,209	Open grazing	¾ mile		
	3.30 p. m.	2	1,100–1,100	Timber grazing	¾ and ¾ mile		Separated in timber.
	7 p. m.	2	1,100–1,100	Open grazing	1¼ and 1¼ miles		Near bed ground.
	8 p. m.	1	2,209	Bedding	1¼ and 1¼ miles	Bed No. 1	Came together at bed ground.
28	4 a. m.	1	2,209	Leaving bed ground			
	1 p. m.	1	2,209	Open grazing	¾ mile		Open scattered grazing.
	1.30 p. m.	2	1,400–900	Open timber ground	¾ mile and 1½ miles		Separated in open timber.
	7 p. m.	2	1,400–900	do	1 mile and 1½ miles		
	8 p. m.	1	2,209	Bedding	1 mile	Bed No. 3	Came together on new bed ground.
29	4 a. m.	1	2,209	Leaving bed ground		Bed No. 3	
	1.30 p. m.	1	2,209	In timber	¾ mile		Open grazing in timber.
	2 p. m.	2	800–1,500	do	do		Separated in timber.
	7 p. m.	2	800–1,500	Leaving timber	1 mile		
	8 p. m.	1	2,209	Bedding	1⅛ miles	Bed No. 3	Came together on bed ground.
30	4.30 a. m.	1	2,209	Leaving bed ground			
	9 a. m.	2		In timber	½ mile		Separated in timber.
	12.30 p. m.	1	2,209	Open grazing	½ mile		Came together in timber.
	2.30 p. m.	2		do	½ mile		
	5.30 p. m.	1	2,209	do	1 mile		Came together near bed.
	8 p. m.	1	2,209	Bedding	1¼ miles	Bed No. 4	New bed ground.
July 1	4 a. m.	1	2,209	Leaving bed ground			
	11 a. m.	1	2,209	"Shaded up"	½ mile		In open timber all morning.
	12 a. m.	2		Open grazing	¾ mile		Do.
	5.30 p. m.	1	2,209	Glade, open grazing	1 mile		Came together on way to bed
	7.30 p. m.	1	2,209	Bedding	1½ miles	Bed No. 1	
2	In one band all day.			Open grazing	1 mile	Bed No. 1 at night	One band, traveled little and close grazed in afternoon.

3	4.30 a. m.	1	2,209	Leaving bed ground			
	8 a. m.	3	800–700–700	Open grazing			
	12 a. m.	2	1,500–700	....do	¾ mile		
	6 p. m.	1	2,200	Salted	....do		
	7.30 p. m.	1	2,200	Bedding	1¼ miles	Near bed No. 1	This bed extended over about 30 acres.
4	All day	1	2,209	Close but not trailing	....do	Bed No. 4	
5	....do	1	2,209	Scattered well and moving considerably.	2 miles	Bed No. 5	
6	....do	1	2,209	Scattered and moving	1¼ miles	Bed No. 3	In small bunches several times, but only for short time and close together.
7	4.30 a. m.	1	2,209	Leaving bed ground			
	4.30 p. m.	2	1,500–700	Scattered—Timber grazing	¾ mile		
	7.30 p. m.	1	2,209	Bedding	1 mile	Bed No. 6	Open grazing with but little trailing all day.
8	5:30 a. m.	1	2,209	Leaving bed ground			
	7 a. m.	3	800–700–700	In timber, open grazing	½ mile		
	2 p. m.	2	1,500–700	Open grazing	⅝ mile		
	8 p. m.	2	1,500–700	Bedding	½ mile	Bed Nos. 7, 8	Both new beds.
9	5 a. m.	2	1,500–700	Leaving bed ground			
	6 p. m.	2	1,500–700	Open grazing	½ mile		
	7.30 p. m.	1	2,209	Bedding	⅝ mile	Bed No. 9	New bed.
10	All day	(a)	2,209	Open, scattered grazing	½ mile	Bed No. 10	Small bunches but for short periods.
11	5 a. m.	1	2,209	Leaving bed ground			
	4.30 p. m.	3	800–700–700	Open-glade grazing	⅜ mile		
	7.30 p. m.	2	1,500–700	Bedding	½ mile	Bed No. 11	One new bed; one bunch not located.
12	5 a. m.	2	1,500–700	Leaving bed ground			
	8.30 a. m.	1	2,209	Open grazing	¼ mile		
	8 p. m.	1	2,209	Bedding	½ mile	Bed No. 9	Scattered timber grazing all day.
13	All day	1	2,209	Open grazing	1 mile	Bed No. 12	Grazed in open timber all day.
14	....do	1	2,209	....do	1½ miles	....do	Do.
15	....do	1	2,209	....do	2 miles	Bed No. 13	Considerable trailing.
16	5 a. m.	1	2,209	Leaving bed ground			
	10 a. m.	2	200–2,000	Timber grazing	¼ mile		
	12 a. m.	1	2,209	....do	½ mile		
	7 a. m.	1	2,209	Bedding	1 mile	Bed No. 13	
17	5 a. m.	1	2,209	Leaving bed ground			
	4 p. m.	3	500–700–1,000	Open grazing	¾ mile		
	7 p. m.	1	2,209	....do	1 mile		
	8 p. m.	1	2,209	Bedding	....do	Bed No. 7	Bed covering 20 acres.
18	5 a. m.	1	2,209	Leaving bed ground			
	2.30 p. m.	2	200–2,000	Timber grazing	¼ mile		
	4.30 p. m.	1	2,209	....do	¾ mile		
	8 p. m.	1	2,209	Bedding	1 mile	Bed No. 7	
19	5 a. m.	1	2,209	Leaving bed ground			
	5 p. m.	2	200–2,000	Open grazing	¾ mile		
	8 p. m.	1	2,209	Bedding	1 mile	Bed No. 7	
20	5 a. m.	1	2,209	Leaving bed ground			
	6.30 p. m.	2	300–1,900	Scattered grazing	¾ mile		
	8 p. m.	2	300–1,900	Bedding	1 mile	Bed No. 14	Timber grazing all day; one bunch not located.

[a] Many small bunches for short time.

TABLE 2.—*Actions of 2,209 ewes and lambs at liberty within coyote-proof inclosure*—Continued.

Date.	Time of day.	Number of bunches.	Approximate number of sheep in each bunch.	How grazing.	Approximate distance grazed.	Where bedding.	Remarks.
July 21	5 a. m.	2	300–1,900	Leaving bed ground			
	10 a. m.	1	2,209	"Shaded up"	½ mile		
	4 p. m.	3	400–500–1,000	Scattered grazing	1½ miles		
	8 p. m.	3	400–500–1,000	Bedding	2 miles	Bed Nos. 7, 15	One bed not located.
22	5 a. m.	3	400–500–1,000	Leaving bed ground			
	10 a. m.	2	400–1,800	Timber grazing	½ mile		
	8 p. m.	2	400–1,800	Bedding	1½ miles	Bed Nos. 7, 16	Small bunch bedded out.
23	5 a. m.	2	400–1,800	Leaving bed ground			
	8 a. m.	1	2,209	Open grazing	¼ mile		
	8 p. m.	1	2,209	Bedding	⅛ mile	Bed No. 17	New bed.
24	6 a. m.	2	500–1,700	Open grazing	¼ mile		Separated from bed ground.
	6 p. m.	2	500–1,700	do	⅛ mile		
	8 p. m.	1	2,209	Bedding	⅛ mile	Bed No. 17	Came together on bed.
25	All day	1	2,209	Open grazing	2 miles	Bed No. 7	Grazed heavy timber most all day.
26	7 a. m.	2	1,100–1,100	do	⅛ mile		Separated leaving bed.
	12 a. m.	2	1,100–1,100	do	¼ mile		
	4 p. m.	4	600–500–600–500	do	½ and 1½ miles		
	8 p. m.	2	1,100–1,100	Bedding	1 and 1¼ miles	Beds Nos. 9, 7	
27	5 a. m.	2	1,100–1,100	Leaving bed ground			
	8 a. m.	1	2,209	Open grazing	¼ mile		
	10 a. m.	2	200–2,000	do	⅛ mile		
	8 p. m.	1	2,209	Bedding	¼ mile	Bed No. 7	Came together on bed.
28	5 a. m.	1	2,200	Leaving bed ground			
	12 a. m.	2	1,100–1,100	Open grazing	⅜ mile		
	8 p. m.	2	1,100–1,100	Bedding	¼ mile	Beds Nos. 7, 18	One new bed.
29	9.30 a. m.	1	2,209	Open grazing	¼ mile		Beds July 28 were ¾-mile apart.
	2.30 p. m.	2	200–2,000	do	¼ mile		
	8 p. m.	2	200–2,000	Bedding	1¼ miles	Bed No. 19	One new bed; one bunch not located.
30	7 a. m.	1	2,209	Open grazing	1¼ miles		
	8 p. m.	1	2,209	Bedding	¾ mile	Bed No. 20	One band all day; open grazing; new bed.
31	3 p. m.	1	2,209	Scattered grazing	¼ mile		One band all day.
	4 p. m.	5		do	⅛ mile		All in timber.
	8 p. m.	3		Bedding	1 mile	Beds Nos. 20, 21, 22	Two new beds.
Aug. 1	7.30 a. m.	2	200–2,000	Scattered	¼ mile		
	8 p. m.	2	200–2,000	Bedding	1½ miles	Beds Nos. 23, 17	One new bed.
2	9 a. m.	1	2,209	Open grazing	¼ mile		Came together in morning.
	2.30 p. m.	2	1,100–1,100	do	⅛ mile		
	8 p. m.	2	1,100–1,100	Bedding	1 mile	Beds Nos. 23, 24	One new bed.
3	6.30 a. m.	1	2,209	Scattered grazing			
	1 p. m.	2	1,100–1,100	do	½ mile		
	8 p. m.	1	2,209	Bedding	1 mile	Bed No. 23	Came together at 6.30 p. m.

4	All day	1	2,209	Timber, scattered grazing	do	Bed No. 7	
5	5 a. m.	1	2,209	Leaving bed ground			
	6 p. m.	2	1,000–1,200	Open grazing	¾ mile		
	8 p. m.	2	1,000–1,200	Bedding	1 mile	Beds Nos. 7, 17	
6	8 a. m.	1	2,209	Open grazing	½ mile		
	6 p. m.	2	800–1,900	do	¾ mile		
	8 p. m.	2	800–1,900	Bedding	1 mile	Beds Nos. 23, 25	Separated in timber.
7	7 a. m.	1	2,209	Open grazing	¼ mile		
	9 a. m.	2	700–1,500	do	⅝ mile		
	8 p. m.	2	700–1,500	Bedding	½ and 1 mile	Beds Nos. 23, 26	One new bed.
8	7 a. m.	3	700–800–700	Scattered	½ mile		Bunch separated at bed ground.
	6 p. m.	4	700–700–600–200	do	¾ mile		
	8 p. m.	2	700–1,500	Bedding	1 mile	Beds Nos. 23, 26	Three bunches came together on bed.
9	All day	2	700–1,500	Scattered	½ and 1 mile	Beds Nos. 23, 27	Apart all day.
10	do	2	700–1,500	do	1½ miles	Bed No. 23	Very restless and were put together at night.
11	4.30 p. m.	2	1,100–1,100	Openly	1 mile		Separated at 4 p. m.
	8 p. m.	1	2,209	Bedding	1⅛ miles	Bed No. 9	Came together at 6 p. m.
12	All day	1	2,209	Openly	¾ mile	Bed No. 28	New bed ground.
13	10 a. m.	2	1,100–1,100	do	1½ miles		Separated at 10 a. m.
	5.30 p. m.	1	2,209	do	2⅛ miles		Came together at 5.30 p. m.
	8 p. m.	1	2,209	Bedding	3 miles	Bed No. 29	New bed. A cold, foggy day.
14	4 p. m.	2	1,900–300	Scattered	¾ mile		Separated at 4 p. m.
	8 p. m.	2	1,900–300	Bedding	1 mile	Beds Nos. 29, 30	One new bed.
15	11.30 a. m.	1	2,209	Scattered	½ mile	Bed No. 29	Apart all morning.
	8 p. m.	1	2,209	Bedding	1 mile	do	Together all afternoon.
16	4 p. m.	2	1,100–1,100	Scattered	¾ mile		Separated at 4 p. m.
	8 p. m.	2	1,100–1,100	Bedding	1 mile	Beds Nos. 28, 31	
17	9 a. m.	1	2,209	Scattered	⅜ mile		Came together at 9 a. m.
	1.30 p. m.	2	1,000–1,200	do	½ mile		Separated at 1.30 p. m.
	5 p. m.	1	2,209	do	⅝ mile		Came together at 5 p. m.
	8 p. m.	1	2,209	Bedding	1 mile	Bed No. 31	
18	All day	1	2,209	Scattered	¾ mile	Bed No. 32	New bed.
19	3 p. m.	2	1,100–1,100	do	½ and ⅝ mile		Separated at 3 p. m.
	8 p. m.	2	1,100–1,100	Bedding	⅝ and ¾ mile	Beds Nos. 33, 34	Both new beds.
20	3 p. m.	3	1,100–800–300	Scattered	½, 1¼, and 1½ miles		Separated into 3 bunches at 3 p. m.
	8 p. m.	2	1,100–1,100	Bedding	⅞, 1½, and 1½ miles	Beds Nos. 34, 35	New beds. Came together at bed.
21	3 p. m.	3	1,100–800–400	Scattered	1¼, ¾, and ¾ miles		Separated to 3 bands at 3 p. m.
	8 p. m.	2	1,100–1,100	Bedding	1½ and 1 miles	Beds Nos. 36, 37	New beds.
22	9 a. m.	1	2,209	Scattered	¾ and ½ mile		Came together at 9 a. m.
	8 p. m.	1	2,209	Bedding	1¼ and ¾ miles	Bed No. 1	
23	11 a. m.	3	800–700–700	"Shaded up"	½ mile		Separated in timber 10 a. m.
	1 p. m.	1	2,209	Scattered	⅝ mile		
	8 p. m.	1	2,209	Bedding	1 mile	Bed No. 1	40-acre bed ground.
24	4 p. m.	5	400–500–300–500–500	Scattered	½ mile		
	8 p. m.	1	2,209	Bedding	¾ mile	Bed No. 38	Bedded scattered over 15 acres.
25	5 a. m.	2	1,100–1,100	Leaving bed ground			Separated at bed.
	9 a. m.	3	1,100–800–300	Scattered	¼ mile		
	10.30 a. m.	2	1,100–1,100	do	⅛, ⅜, and ⅜ mile		
	8 p. m.	2	1,100–1,100	Bedding	⅜ and ½ mile	Beds Nos. 38, 39	One new bed.
26	8 p. m.	1	2,209	do	¾ and 1¼ miles	Bed No. 38	Grazed in 2 bands all day. Came together on bed.

TABLE 2.—*Actions of 2,209 ewes and lambs at liberty within coyote-proof inclosure*—Continued.

Date.	Time of day.	Number of bunches.	Approximate number of sheep in each bunch.	How grazing.	Approximate distance grazed.	Where bedding.	Remarks.
Aug. 27	8 a. m.	2	1,200-1,000	Scattered	¼ mile		
	5 p. m.	4	700–500–700–300	do			
	8 p. m.	4	700–500–700–300	Bedding			Bedding on ground used before.
28	12 a. m.	3	1,400–500–300	Scattered	1½ miles		Cold, stormy day.
	8 p. m.	3	1,400–500–300	Bedding	3 miles	Old beds	
29	All day	3	1,400–500–300	Scattered	do	do	Cold and stormy.
30	9 a. m.	2	1,400–800	do	¼ mile		
	8 p. m.	2	1,400–800	Bedding	⅜ mile	Beds Nos. 7, 29	Grazed in timber all day.
31	1 p. m.	3	800–1,100–300	Scattered	⅜, ½, and ¾ mile		Separated in timber.
	8 p. m.	3	800–1,100–300	Bedding	½ and ¾ mile	Beds Nos. 40, 41	One bunch not located.
Sept. 1	3 p. m.	2	1,400–800	Scattered	¼ and ½ mile		Small bunches driven in.
	8 p. m.	2	1,400–800	Bedding	¾, and ⅞ mile	Beds Nos. 42, 43	New beds.
2	8 a. m.	3	700–700–800	Scattered	¼, ½, and ¼ mile		
	5.30 p. m.	2	1,400–800	do	⅜, ⅜, and ⅜ mile		In thicket all day.
	8 p. m.	2	1,400–800	Bedding	½, ½, and ½ mile	Beds Nos. 44, 45	New beds.
3	4 p. m.	3	700–700–800	Scattered	¼, ½, and ¼ mile		In heavy timber.
	8 p. m.	2	1,400–800	Bedding	¾ and ⅞ mile	Beds Nos. 44, 7	
4	4 p. m.	3	900–500–800	Scattered	¾, ⅞, and 1 mile		
	8 p. m.	2	1,300–900	Bedding	1, 1, and 1⅛ miles	Beds Nos. 44, 9	Small bunch grazed to water.
5	7 a. m.	1	2,209	Scattered	¼ mile		
	4 p. m.	2	1,000–1,100	do	⅜ mile		
	8 p. m.	2	1,100–1,100	Bedding	1 mile	Beds Nos. 46, 42	One new bed.
6	4 p. m.	1	2,209	Scattered	1 and ½ mile		
	8 p. m.	1	2,209	Bedding	1, ⅛, and ⅜ mile	Bed No. 42	
7	4 p. m.	2	300–1,900	Scattered	1 mile		Separated at 4 p. m.
	8 p. m.	2	300–1,900	Bedding	1⅛ miles	Beds Nos. 42, 47	One new bed.
8	11 a. m.	3	200–100–900	Scattered	¼ ¼, and 1 mile		
	8 p. m.	2	200–1,900	Bedding	½, ½, and 2 miles	Beds Nos. 48, 49	Bothnew beds.
9	11.30 a. m.	1	2,209	Bunched	½ mile		Grazed together.
	8 p. m.	1	2,209	Bedding	1½ miles	Bed No. 47	
10	10 a. m.	2	800–1,400	Scattered	½ and ¾ mile		Separated in timber.
	2 p. m.	3	800–1,100–300	do	⅝, ⅞, and ⅞ mile		
	8 p. m.	3	800–1,100–300	Bedding	1, 1¼, and 1¼ miles	Beds Nos. 7, 9, 50	One new bed.
11	10 a. m.	4	300–500–1,100–300	Scattered in timber	¼, ¼, ½, and ¼ mile		Scattered in timber.
	5.30 p. m.	3	600–500–1,100	Scattered	⅜, ½, ½, and ¾ mile		Do.
	8 p. m.	3	600–500–1,100	Bedding	½, ⅝, ¾, and 1 mile	Beds Nos. 7, 50, 43	
12	10 a. m.	1	2,209	Scattered	¼ mile		Came together in thicket.
	12 noon	2	400–1,800	do	⅜ mile		Separated in timber.
	8 p. m.	2	400–1,800	Bedding	½ and ½ mile	Beds Nos. 7, 51	
13	2.30 p. m.	4	300–1,200–350–450	Scattered	¾, ¾, ¾, and ½ mile		In timber all morning.
	8 p. m.	3	1,500–350–350	Bedding	1, 1, and ¾ mile	Beds Nos. 52, 53, 54	Three new beds.

14	8 a. m.	4	600–900–350–350	Scattered			Grazing in timber.
	8 p. m.	3	950–900–350	Bedding	1½, 1½, and 1 miles	Beds Nos. 17, 7	One bunch not located.
15	7.30 a. m.	4	950–600–300–350	Scattered			
	8 p. m.	3	1,200–600–350	Bedding	2, 1½, and 1 miles	Beds Nos. 1, 7, 17	Considerable trailing.
16	3.30 p. m.	4	1,250–300–300–300	Scattered			Widely scattered.
	8 p. m.	4	1,250–300–300–300	Bedding	1½, 1½, 2, and 2 miles.	Old beds	Do.
17	All day	4	1,250–300–300–300	Scattered	2 miles	Beds used before	Widely scattered and trailing much.
18	10 a. m.	3		do			
	3 p. m.	4	800–900–100–400	do			
	8 p. m.	2	800–1,400	Bedding	2½ miles	Beds Nos. 7, 24	Stormy day; sheep moved considerably.
19	8.30 a. m.	1	2,209	Scattered			
	2.30 p. m.	3	900–1,000–300	do			
	8.30 p. m.	2	1,900–300	Bedding	2½ miles	Beds Nos. 9, 37	
20	7.30 a. m.	3	1,000–900–300	Scattered			
	3 p. m.	1	2,209	Bunched			Rounded up to make weighings of lambs.
	8 p. m.	1	2,209	Bedding		Bed No. 9	
21	8 a. m.	3	1,100–1,000–200	Scattered			
	8 p. m.	2	1,000–1,200	Bedding	1½ and 2 miles	Beds Nos. 1, 9	
22	2 p. m.	4	50–500–900–750	Scattered			
	8 p. m.	3	500–950–750	Bedding	2 miles	Ground used before	Moving so much that accurate record was not kept.
23	8.30 a. m.	2	500–1,700	Scattered			
	1.30 p. m.	3	500–500–1,200	do	1, 1½, and 1½ miles		
	8 p. m.	4	50–500–500–1,200	Bedding	1½, 2, and 2 miles	Beds Nos. 1, 55, 56	Two new beds—one bunch not located.
24	7 a. m.	3	550–500–1,150	Scattered			Small bunch driven in.
	5 p. m.	3	550–500–1,150	do			
	7 p. m.	1	2,209	Bedding		Bed No. 57	Rounded up ready for final count, Sept. 25.

Loss of sheep during the pasture period June 21 to September 25, 1908.

September 25, 7 a. m., the sheep were counted and turned over to the owner.

Count when turned into the pasture, June 21, 1908			2,209
Count when taken from the pasture, September 24, 1908			2,194
Loss during season, June 21 to September 24, 1908, 96 days:			
a. By poisonous plants—			
Lambs	4		
Ewes	1		
		5	
b. As a result of timber snags: ewes	3		
c. From "flyblow:" lambs	1		
d. Resulting from bruises in shearing: ewes	2		
e. For mutton	3		
f. Unaccounted for	1		
		15	
Total count			2,209

DISCUSSION.

1. Will Sheep Separate into Small Bunches?

The number of bunches varied from one to five, and the approximate number of sheep in each bunch from 50 to 2,209. Many times they would separate into two or more bunches as they left the bed ground and remain apart for two or three days, or perhaps come together again within a few hours, while at other times they would remain in one band until late afternoon, when they would separate into several bunches and be a mile or more apart at bedding time. Occasionally they would separate in the morning, come together within a few hours, again separate, and then unite before bedding at night. It was not uncommon for them to bed in from two to four bunches, a mile or more apart, and be in one bunch within a few hours on the following day.

Though what has just been said is true for the period as a whole, the table shows that after the first week of freedom there was a growing tendency toward more bunches, both during the day and at night. This tendency was even more pronounced than can be shown in the table. During the first two weeks there was little change from day to day. The sheep were still under the spell of herding methods. They would leave the bed in one herd, and, while they did not always remain closely bunched, those that were behind would trail up. When evening came they would take the back trail to the bed ground. Later in the season they would graze in different directions, even from the bed ground. If the range happened to be open they would scatter over a quarter or half mile square without separating. If in timber, they would usually separate, and later the secondary bunches would separate.

The number and size of the bunches, as well as the time that they spend apart, would depend to a large extent upon the size and topography of the inclosed area. In an area much larger than the pasture and as heavily timbered, the sheep when separated would not get together so easily. In a smaller area there would be less separation. In an area without timber the separations would be for a short time only.

Whether the large or the smaller pasture is preferable depends upon the class of sheep using it. With dry sheep it is not necessary for them ever to be together. This is not true of ewes and lambs. A band will not break up into small bunches without a great many ewes being separated from their lambs. If they remain apart more than a few days, at most, during the early part of the season, the lamb becomes a stunted orphan and the ewe is in danger from a spoiled udder. This feature was closely watched during the experiment. At the beginning of the season, when the lamb lives almost entirely upon milk, he is making his most rapid growth. At such a time he would be set back considerably if deprived of his milk even for twenty-four hours, especially if it happened frequently. Near the close of the season the effect is much less detrimental. During the past season it was necessary, on a few occasions, to put the band together, both for the good of the sheep and to protect the range. After being separated for perhaps twelve hours, both ewes and lambs are very uneasy, and trail about, destroying much more forage than they eat.

2. Open Grazing.

Whether sheep are in large or in small bunches it is essential for the protection of the range that they be well scattered and graze quietly. Close-bunched grazing, massing, running, and trailing one after another should be prevented if possible, not only for the good of the range but for the good of the sheep. In this respect there was marked change during the season. At first the band was usually well scattered, but there was more or less bunching and considerable trailing. As the sheep gradually became accustomed to free, unmolested grazing, and forgot the habits learned when herded, there was much less massing. Except during stormy weather and when running for the green fall grass, there was little trailing. Not only did they graze openly during the day, but usually, when bedded at night, the band would cover several acres, instead of the 1-acre bed ground customary when herded. The result was that little or no damage was done to the forage crop in this way. The entire crop was eaten and not wasted. (For an illustration of open grazing in the pasture, see fig. 4.

3. Rambling About.

The amount of rambling and trailing done by the ewes and lambs was variable, and depended, as in the case of dry sheep, upon many factors besides the natural instinct of the sheep to ramble. Those most important were the character of the range, atmospheric conditions, disturbances, and whether or not each ewe and her lamb were together.

Table 2 shows that the distance traveled during a day was greater toward the close of the season than during the earlier part. It also shows days when the distance was very much greater than on others. This may be accounted for by the fact that at first there was plenty of choice feed everywhere, that there was little or no stormy weather, and that the band was seldom broken up for any length of time. Later in the year the feed was shorter, ewes and their lambs were often separated for two days or more, and there were occasional storms. When the fall growth of grass began to come on the glades, the sheep would not graze elsewhere as long as they could chase about and get a moderate amount of the tender green foliage. During this period, too, occasional stormy days drove them from the browse in the timber and caused them to wander about.

In this connection, however, the statement made in Circular 156 may be confirmed. If sheep travel spread out little damage is done to range, unless the forage crop is very heavy and tall. If they are bunched, so many hoofs strike each plant that it is unable to recover from the trampling. If they trail one after another the result is a series of beaten paths where the forage can not grow. During the season, as a whole, there was comparatively little trailing and bunched grazing. As a result, the forage crop was fully utilized and the pasture area is marked by very few of the beaten trails common on the outside sheep ranges.

4. Do Sheep Bed in Large Bands when Free?

The number of bunches in which the sheep bedded varied from one to four, and the number of sheep in each bunch from 50 to 2,209 head. The number of bunches bedded, as a rule, was less than the number at large during the day, showing a tendency to collect for the night. However, the table shows that the number of bunches in which the animals bedded toward the close of the season was greater than at first. During the first thirty days they bedded in one band twenty-six nights. During the last thirty days, up to September 23 inclusive, they bedded in one band only four nights.

This change in habit came chiefly from the system of handling. Other factors, however, aided in the change. In the early part of

the season each ewe was very careful of her lamb, and, rather than bed without it, would spend the late afternoon hours in a search for it. This had a tendency to bring the bunches together. Later in the year some of the ewes even weaned their lambs, and, in general, neither ewe nor lamb searched for each other as much as earlier in the season. Aside from this, the feed was much better in the early season, and in consequence the sheep did not scatter so widely and the bunches during the day did not get so far apart.

The natural development of the system, however, was toward more bunches. Moreover, at the close of the season, bunches would often bed within a quarter of a mile of each other without any attempt to join.

5. Choosing Bed Ground.

Of the 2,560 acres of pasture only 860 acres is open area, about one-half of which is suitable for a bed ground. In column 7 of Table 2, two things are especially noticeable; first, the great number of beds chosen, and, second, the increase in this number as the season advanced, notwithstanding the fact that so many old beds existed. One other important feature, not shown in the table, was that many of the bed grounds covered an area of several acres.

At the close of the season there were very few glade areas suitable for bed grounds that had not been used. In all, 57 bed grounds were chosen, several of them covering from 10 to 30 acres. Except in perhaps two places, the bedding was helpful rather than detrimental to the growth of vegetation.

During the first two weeks only 4 bed grounds were used; in the second two weeks 9 new bed grounds were chosen in addition to the old ones; during the third period of two weeks 10 new ones were used; in the fourth period of the same length, 7; in the fifth, 9; and in the sixth, 15. During the fourth period the sheep were grazing the area used in the second and third periods, where the beds already chosen occupied most of the ground suitable for that purpose. Aside from the new beds recorded, the band would often bed on the the outskirts of ground already used. This fact partly accounts for beds covering many acres.

Sheep bedded under the herding system are usually crowded very close together on a bed that has been used many times. Naturally, the experimental band continued this habit when first turned loose. In the end, however, not only were they usually satisfied to bed where night overtook them, but when using an old bed ground there was a marked tendency to choose new, clean ground rather than that previously used. Further, it was not uncommon to see them spread over 4 or 5 acres in such a way that each sheep was at least a few feet

from any other. This marked change during the season in the choice of bed ground is an excellent example of the natural development toward freedom of action by the band and by individuals.

SUMMARY.

In brief, it may be said that, when entirely protected from destructive animals and unmolested by herders and dogs, a band of ewes and lambs will separate into bunches, come together again, and perhaps again separate while grazing; that they will graze very much more openly and do less trailing than when herded; that they may travel as far, perhaps, as when herded, but because they are scattered and pass over an area only once, the movement is less injurious to the forage crop; that their natural tendency is to bed at night in bunches, but in smaller bunches than when herded; that after they become accustomed to this free system of grazing they are contented to bed wherever night overtakes them, if suitable ground can be found.

EFFECTS OF SUCH A GRAZING SYSTEM UPON THE SHEEP AND THE CARRYING CAPACITY OF THE RANGE.

THE SHEEP.

Sheepmen have known that sheep do much better when allowed to scatter over a range and graze unmolested than when continually dogged and closely bunched by a herder. They have made little or no attempt, however, to determine definitely the difference between sheep when herded and when allowed perfect freedom.

During 1908 this problem was taken up at the coyote-proof pasture. Comparisons were made of the lambs of the experimental band in the pasture with lambs from bands on outside range, handled under the usual system of herding, to determine the difference in growth during the season, weight at the close of the season, wool crop, and loss during the season.

COMPARATIVE GROWTH.

At the beginning of the summer grazing in the pasture, June 24, twenty lambs of average size from the experimental band were weighed and marked so that they could be weighed again at the close of the season. The same number of lambs were chosen in the same manner, weighed, and marked, from a band of sheep of the same class, which had wintered and lambed on the same range as the pasture band. During the summer they were under the care of an excellent herder on range near the pasture, but richer in forage value than the inclosed area and much larger in extent.

The band from the coyote-proof pasture was first weighed on June 24, when 85 days old. The average weight of the sheep was 52.7 pounds. On September 20, when 173 days old, they were weighed a second time, and the average weight was found to be 72.7 pounds, a gain in eighty-eight days of 20 pounds. The sheep from the outside range were first weighed on June 28, when 75 days old, and showed an average weight of 49 pounds. They were again weighed on October 2, when 171 days old, and the average weight was found to be 64 pounds, a gain in ninety-six days of but 15 pounds, as compared with 20 pounds in eighty-eight days by the pastured sheep. Moreover, the age of the two bands at the time of final weighing was approximately the same, yet the average weight showed an advantage of 8.7 pounds in favor of the animals from the coyote-proof pasture.

The range band from which the above weighings were made was the best band of sheep of this class on the grazing lands near the pasture area. As will be shown later, the lambs from one other of the neighboring bands were weighed at the end of the season. They averaged only 62 pounds after a cut of about 100 had been made. It may safely be said that the lambs from most of these bands would not average 60 pounds. They were not weighed because they had been lambed on different range and at a different time. Consequently comparisons could not have been made with exactness.

It may be said, then, that the lambs from the band grazed under the pasture system increased in weight 5 pounds more in eighty-eight days than did the best lambs of the same class grazed under the herding system in ninety-six days. The pastured ewes were correspondingly in better condition than those herded.

WEIGHTS AT CLOSE OF SEASON.

At the time the sheep left the summer range the lambs from two bands that had been summered on range near the coyote-proof pasture and the lambs from four bands that had summered on the high mountain range were weighed in order to compare them with the pastured lambs. From the four high-range bands all the lambs were weighed and the average taken. This was not possible with the other bands, since they were weighed on the range. From the two herds near the pasture 25 lambs, of as near an average size as could be selected, were weighed and an average taken. In weighing the pastured lambs the same method was followed, and an additional test was made by weighing the five smallest and five of the largest in the band. The results are shown in Table 3.

TABLE 3.—*Weight of lambs at close of season.*

Class of sheep.	Where summered.	Date of weighing.	Age.	Number weighed.	Average weight.
					Pounds.
One-fourth Merino, three-fourths Rambouillet. (J. H. Dobbin.)	Coyoteproof pasture.	Sept. 20	173 days	20 average lambs..	72.7
				5 smallest and 5 of largest.	70.7
Do	Herded on range near coyote-proof pasture.	Oct. 2	171 days	20 average lambs..	64
One-fourth Merino, three-fourths Rambouillet. (Smith & Baldwin.)	do	Sept. 21	Approximately 170 days.	25 average lambs..	62
One-half Merino, one-half Shropshire, 952 wether lambs. (J. H. Dobbin.)	On high mountain range, herded.	Oct. 1	do	All	69.5
One-half Merino, one-half Shropshire, 433 head. (E. F. Johnson.)	do	do	do	do	64.6
One-fourth Merino, three-fourths Shropshire, 790 head. (Dobbin & Falcner.)	do	do	do	do	63.7
One-half Merino, one-half Shropshire, 616 head. (Falcner.)	do	do	do	do	63.2

It should be remembered that the pastured lambs were not put in the inclosure until they were 80 days old; consequently the increase in weight was made in three months. It is also important to remember that half-Shropshire lambs, when handled under the same system of grazing and on similar range, usually outweigh Merino and Rambouillet lambs by from 5 to 8 pounds. So far as could be ascertained each outside band, except perhaps the Smith & Baldwin sheep, had forage equal to or excelling that on the inclosed area. The Smith & Baldwin band used 75 per cent more range per head than did the pasture band, but the water facilities were not as good. High mountain range is considered much better for lambs than that near the pasture area.

At the time of the fall weighings the wether lambs of J. H. Dobbin were sold at 3¼ cents a pound live weight. At this rate the lambs from the pasture band would bring about 32 cents more than the best lambs of the same class from bands that had been herded. At the prices of the preceding year, 1907, the increase would have been 44 cents a head.

That the ewes were in excellent condition, almost mutton fat, is quite as important as that the lambs were good. It means light loss during the winter, good condition at lambing time in spring, a better lamb crop, and a heavy wool crop.

COMPARATIVE LOSS.

On the Wallowa National Forest sheepmen usually expect a loss of from 5 to 10 per cent from their herds during the year. Comparative data were obtained, however, for the period of summer grazing only. Table 4 shows these losses.

TABLE 4.—*Loss of sheep.*

Owner.	Where grazing.	Period, 1908.	Number of sheep.	Loss in sheep.	Per cent loss.
J. H. Dobbin	High mountain range	June 15–Oct. 1	10,000	300	3
Do	Near coyote-proof pasture	July 10–Oct. 1	2,800	39	1.4
H. Kernan	do	June 20–Sept. 20	5,000	150	3
Smith & Baldwin	do	do	3,000	85	2.8
J. H. Dobbin	Coyote-proof pasture	June 21–Sept. 25	2,209	12	.5

The average loss from outside bands in three months approached 3 per cent, while in the pastured band it was only 0.5 per cent.

WOOL GROWTH.

The wool growth under the pasturage system of grazing would undoubtedly be heavier and much cleaner. Thus far no data have been secured on this point, but an attempt will be made to get a test at shearing time in 1909.

SUMMARY.

Briefly, it may be said that after being handled under the pasturage system for three months, between the ages of 3 and 6 months, lambs weighed 8 pounds more than the best lambs of the same class that had been herded; that the loss from the pastured band during the three months was 0.5 per cent as against 3 per cent from bands herded on outside range; that the pasturage system gives a heavier and cleaner wool crop.

The condition of the pastured ewes and lambs at the end of the season is well shown in figure 5. The photograph was made not from a picked bunch, but from one in which the sheep had separated of their own accord from the main band.

CARRYING CAPACITY OF THE RANGE.

The effect of the pasturage system upon the carrying capacity of the range can best be determined by a comparison of the carrying capacity of range when grazed under this system and when grazed by sheep that are herded. To obtain a high degree of accuracy in such a comparison it would be necessary to have:

(1) Two areas exactly alike in forage and in topography.
(2) The surface acreage accurately measured.
(3) Equal water facilities.
(4) Each protected from trespassing animals.
(5) Each grazed by the same class and breed of sheep.
(6) The areas in equally good condition at the close of the grazing season.

Obviously, these conditions could not be fully attained where the range is rugged and the forage crop is slightly varying. However,

it was possible during 1908 to secure results wherein the per cent of error is no higher than would be the per cent of difference in carrying capacity of any one area when used by a poor herder and when used

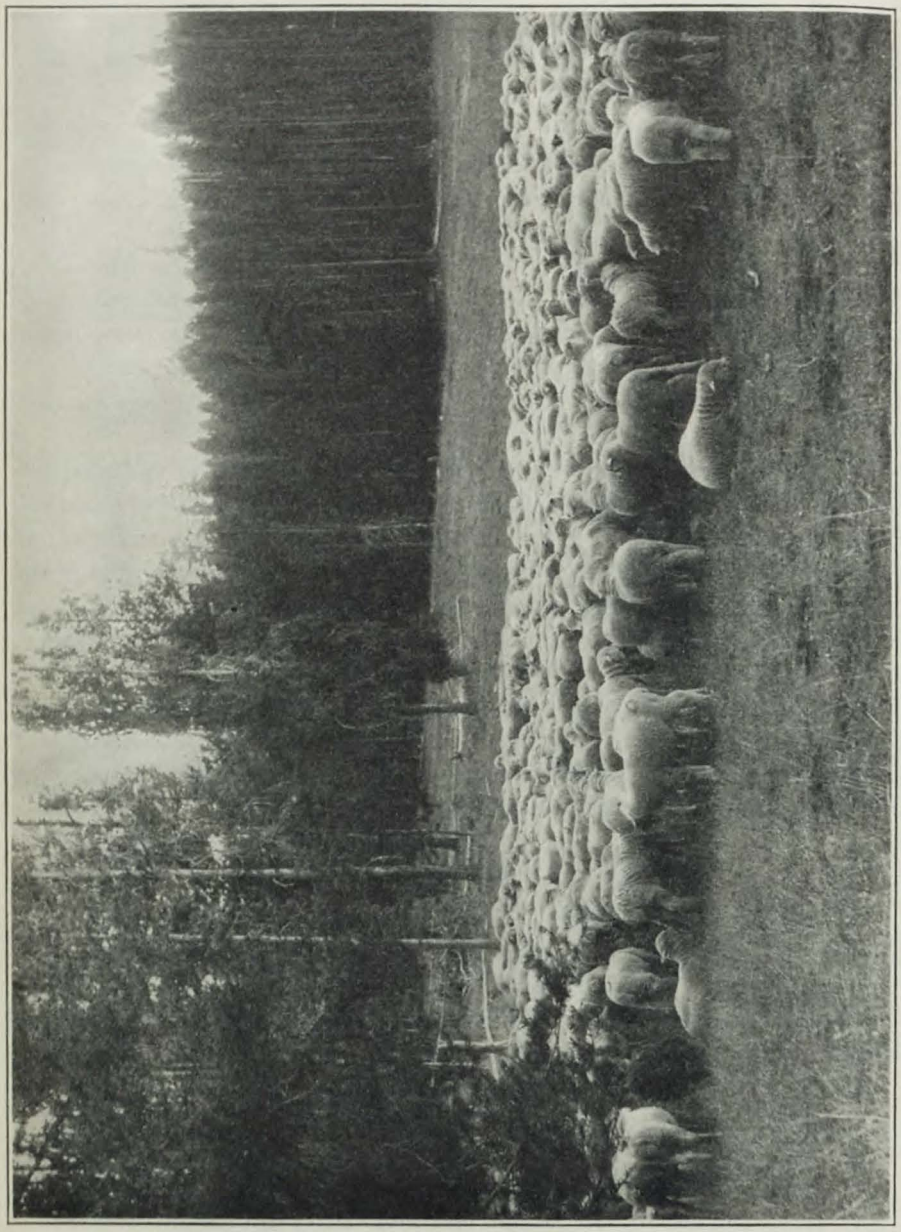

FIG. 5.—A small bunch of pastured sheep at the close of the season.

by a good one. A range is seldom grazed by the same herder for successive years, and the estimate that follows should be applicable to general range conditions.

The area used for comparison joins the pasture on the north, south, east, and west. It is similar to the inclosed land in topography and forage crop, though its water facilities as a whole are not so good, and it is encroached upon to some extent by cattle from adjoining areas. It was grazed by five bands of Merino and Rambouillet ewes with their lambs, the same class and breed as the experimental band. At the close of the season portions of the outside range were in a worse condition than the pasture, while other portions were not so closely grazed.

The acreage was obtained by making a traverse survey of each allotment, and from this calculating the area. Accurate surface acreage, of course, was not obtained on account of deep canyons and many undulations. An effort was made, however, to use about the same per cent of waste range in each of the allotments. The data are tabulated in Table 5.

TABLE 5.—*Comparative carrying capacity of pastured and open range.*

Permittee.	Total sheep.	Equivalent in old sheep.[a]	Total time of grazing.	Total acreage.	Total average acres per day for band.	Average acres per day per sheep.	Average acres per sheep for 90 days.	Additional grazing area required by herded sheep over pastured sheep.
								Per cent.
Experimental band	1,200 ewes, 1,000 lambs.	1,700	June 21–Sept. 25 (96 days).	2,560	26.6	0.0156	1.412	.....
H. Kernan..... ..	2 bands (3,000 old sheep, 2,000 lambs).	4,000	June 20–Sept. 18 (90 days).	9,268	102.9	.0257	2.317	64
Smith & Baldwin..	1 band (1,600 old sheep, 1,400 lambs).	2,300	June 26–Sept. 20 (85 days).	5,387	63.3	.0275	2.480	76
Michellod & Robin.	2 bands (2,800 ewes, 2,400 lambs).	4,000	July 2–Sept. 30 (90 days).	12,608	140.6	.0350	3.152	[b] 123

[a] Two lambs estimated as one ewe.

[b] The very large area required in this case was due in part to trespass by cattle. (See discussion on p. 32.)

The allotment of Kernan, as measured, compares very favorably with the pasture area in forage-crop and topographic features. There was a slight amount of trespass from cattle. The range at the close of the season was very closely grazed near camps, but was only moderately grazed at remote corners. The fall growth of grass on the range grazed in the early season was not fully utilized. As a whole, perhaps, it was not so closely grazed as the pasture area. The bands were herded by men of about average skill, and at the season's close the sheep were much poorer than the experimental band.

In forage value the Smith & Baldwin allotment is fully as good as the pasture, but the sheep are at a disadvantage from water shortage.

The midsummer grazing is not as good; the early summer and late summer grazing are better. In computing the acreage most of the trespass was eliminated. As a whole the allotment was hardly as closely grazed as the inclosed area, but showed the effects of trailing and tramping very much more. The sheep were in charge of an excellent herder, and at the close of the season were in only fair condition, the lambs being at least 10 pounds lighter than the pastured lambs.

The Michellod & Robin allotment could not be grazed to the best advantage, partly because of poor water supply and partly from the fact that too much of it is weed range that deteriorates materially after August 1. This allotment, too, was subjected to heavy trespass from cattle. At the close of the season most of it was very closely grazed. However, this was due in large part to poor herders, who were of French descent, unable to speak English. Their aim was to get through the season with the proper count. The condition of sheep meant little to them; the condition of the range meant nothing. All factors considered, sheep thus handled would require at least 75 per cent more range than when pastured.

It is safe to conclude that range grazed under the pasturage system will carry 50 per cent more sheep than when grazed under the herding system, where the band is driven to and from camp each day. Whether the increase in carrying capacity is greater than 50 per cent will depend chiefly upon the herder, but in part upon the character of the forage crop.

It is best not to enter into a detailed discussion of the factors that are responsible for the increase in carrying capacity until the results of another season are obtained.

SHEEP GRAZING IN A COYOTE-PROTECTED PASTURE OWNED BY J. W. EMMONS.

The experimental coyote-proof pasture at Billy Meadows, Oregon, was constructed very substantially by the Forest Service under adverse circumstances. As a result the first cost was high and has caused sheepmen to comment upon the proposition as impracticable on account of the expenditure exceeding the advantages accruing from the pasturage system. It is gratifying, therefore, to be able at this time to supplement the discussion already given by a brief report on a pasture constructed and maintained on a paying basis by a private individual.

Mr. J. W. Emmons, of Troy, Wallowa County, Oreg., owns in the neighborhood of 2,000 acres of land lying on the breaks of the Grande Ronde River. Perhaps 1,000 acres of this area will yield readily to agricultural cultivation, while the remainder is open yellow pine forest and break range. Mr. Emmons conceived the idea of handling

1,000 ewes and their increase the year round by utilizing a small amount of break range on the public domain near by and feeding a short time in winter.

In the spring of 1907 he constructed 1,700 rods of fence, inclosing approximately 375 acres of open yellow pine forest and break range, and 225 acres of cultivated wheat land. The total area had previously been in four separate inclosures. The division rail fences were left standing in order to facilitate handling and to protect the grain crop.

FENCE.

SPECIFICATIONS.

The fence, designed to be coyote-proof, was as follows:

Posts from 3 to 5 inches square and 7 feet long, driven 2 feet into the ground 8 feet apart; about 3 inches above the ground a common barbed wire; 3 inches above this a 26-inch woven wire, graduated from the bottom up, the top mesh being an 8-inch diamond; 7 inches above the woven wire a barbed wire; 11 inches higher another barbed wire; total height, 50 inches.

CONSTRUCTION.

The construction work was not difficult. There were no large canyons to cross; the entire fence line was easily accessible; there was little or no clearing to be done, and it was possible to drive practically all of the posts. Nevertheless, the fence was not put up in the best of condition. Many wash holes were filled by throwing in a rotten log, which perhaps would conform to the contour of the hole and perhaps not. There are many places, too, where the bottom wire is 6 inches from the ground surface. At other points sheep have jumped into the woven wire and have left holes approximately 10 inches in diameter. And there are places where the ground slopes to the inside of the pasture at an angle of approximately 10°. It is evident that in such instances a coyote jumping from a point 7 feet outside the fence would have to rise only 3½ feet. These facts are given not for the purpose of adverse criticism, but in order that reliable conclusions may be drawn as to the possibility of fencing against coyotes.

COST.

The total cost of wire at Enterprise, Oreg., then 46 miles from the nearest railroad point and 45 miles from the Emmons ranch, was 55 cents a rod. The transportation and distribution was done by Mr. Emmons's own teams at odd times during winter and early spring. The posts were split from timber obtained on his own land near the fence line. Much of the construction work was done by Mr. Emmons himself. Under these conditions the cash outlay for the 1,700 rods of fence was approximately $1,200, or 71 cents a rod.

EFFICIENCY AS A PROTECTION AGAINST COYOTES.

No record was kept of the number and kind of animals that came to the fence. Occasionally someone would ride the line for the purpose of inspection, but not often. So far as known, coyotes were the only predatory animals. During the season of 1907, June 1 to August 31, one coyote was seen within the inclosure. In May of 1908 coyotes entered on several occasions and killed lambs during the night. After a few holes were repaired under the fence, however, there was no more trouble from coyotes during the season. It was apparent that on each occasion the animals passed to the inside through holes under the fence.

ACTIONS OF EWES AND LAMBS AT LIBERTY IN THE PASTURE.

In order to fully appreciate a discussion on this feature of the system it is essential to have in mind that—

(1) The grazing area consisted of 375 acres of land, covered for the most part with a very open yellow pine forest.

(2) The area is separated by only a narrow lane from the barns and corrals where the ewes had many times been fed, salted, and bedded.

(3) Part of the time one or two of the three division pastures were closed to grazing, which fact resulted in the area grazed being approximately 160 acres.

(4) Ordinarily the sheep were salted near the corrals.

In 1907 the band, consisting of 730 ewes and 630 lambs, was turned loose on June 1 and remained in the inclosure until about August 31. They seldom separated into bunches, but usually they were widely scattered, sometimes moving about considerably, and at other times grazing quietly. Each night during the season they bedded in one band. When they were free to do so they chose the one bed ground near the corrals, where it was customary to salt them.

In 1908, 670 ewes were lambed in the pasture on and after April 15. They, with their lambs, about 550, remained in the area until July 15. They were then removed until August, when they were put in the pasture again for fifteen days during the haying season. During lambing and for some time afterwards they were in three bunches, each bunch in a pasture by itself. The actions under these conditions were similar to those already given for 1907. The small bunches seldom, if ever, separated; they traveled more or less, but were nearly always widely scattered and did little trailing one after another. The sheep in each bunch bedded together at night, and for the most part returned to the same bedding ground night after night.

ACREAGE CARRYING CAPACITY.

An intelligent statement of acreage carrying capacity must give due consideration to—

(1) The type of area grazed.
(2) The acreage per head for a given time.
(3) The condition of the area at the time grazing ceases.
(4) The condition of the animals when the grazing ceases.

THE AREA.

The 375 acres grazed in this case is almost wholly free from down timber; it has almost no waste scab land; it has no heavy forest. Consequently the entire acreage, except where the trees stand, is utilized. A large portion of the area, when fenced, was covered with rather a heavy growth of young yellow pine, varying in size from the mere seedling shoot to the sapling 8 feet high. Much of this growth is dying off under heavy grazing. The forage crop is made up of pine grass (Calamagrostis), a small amount of perennial bunch grasses (Agropyron, Festuca, and Poa), a few species of annual Bromus and other annual grasses, a rather prolific growth of flowering plants, mostly annuals, known locally as weeds, and a considerable amount of rose-bush and willow browse. Of these grazing plants the most important are the pine grass and the so-called weeds. If allowed to mature unmolested by grazing animals the forage ground cover would be dense and comparatively of rank growth. The supply of water consists of occasional small springs which furnish a limited but constant flow, sufficient for the sheep. As a whole, there is much less waste range and the conditions generally favor a somewhat higher carrying capacity on this area than on the area at the Billy Meadows pasture.

ACREAGE FOR EACH SHEEP.

It was not possible to secure the exact number of sheep or the exact dates of grazing, but those used are very near and the resulting error will be insignificant. Considering two lambs as an equivalent of one sheep the results may be outlined as in Table 6.

TABLE 6.—*Carrying capacity of the Emmons pasture.*

Year.	Total sheep.	Equivalent in old sheep.	Dates of grazing.	Number of days.	Total acreage.	Average acreage for each sheep for 3 months.
						Acre.
1907..	Ewes...730 Lambs..630 } 1,360.	1,045	June 1–Aug. 29.....	90	375	0.357
1908..	Ewes ...670 Lambs..550 } 1,220.	945	April 15–July 15 and Aug. 1–15....	106	375	0.343

From these data it is evident that the acreage per head was very low and that the difference in the estimate for 1907 and that for 1908 is very small. A uniform acreage for the two years would be expected. The excessively low acreage per head will be explained by considering the condition of the area and of the sheep.

CONDITION OF AREA AT SEASON'S CLOSE.

The writer did not see the area until April, 1908. Consequently the condition at the close of grazing in 1907 was judged in part from the appearance at the beginning of the growing season in 1908 and in part from information gained from Mr. Emmons.

An examination in April, 1908, showed plainly that the area was grazed beyond its capacity in 1907. There was very little old growth of pine grass existing, which fact is exceptional; no old stalks of weeds or perennial grasses could be seen; the rosebush browse had been robbed of nearly every leaf and many small shoots; and the growth of small yellow pine showed evidence of having been browsed to a considerable extent. Besides, the whole area, while it was comparatively free from beaten paths, presented rather a barren, packed aspect. This judgment is corroborated by a statement as follows by Mr. Emmons: "Night after night they (the sheep) would come in looking full, even after the area was grazed so close that apparently there was nothing to eat." In 1908 the growing season began in late March and early April. The sheep were put on the area April 15. Consequently, the green shoots were cropped to the ground surface from the beginning to the close of the season. During the last month of grazing there was little of anything to eat. This condition of the area at the close of the grazing period, both in 1907 and 1908, no doubt accounts, to some extent, for a carrying capacity many times greater than is usual for similar range where sheep are herded.

THE SHEEP.

According to the owner, the sheep in 1907 were not fat, but in fair condition. When removed from the area in August, 1908, the lambs were thrifty, but not large and not fat. The ewes were thin. However, they compared quite favorably with the average range sheep of the same class. Under the same system, however, with plenty of feed, they would have been at least 15 per cent better

LAMBING IN PASTURE.

That Mr. Emmons lambed his ewes under the pasturage system in 1908 has already been stated. This point, however, is of importance and justifies further discussion.

The lambing began about April 15. At that time the 670 ewes were put into one of the three division pastures. When a lamb was

dropped it was put along with the mother ewe into a second inclosure, where they remained a few days until the man in charge was satisfied that the mother was giving the lamb the care that it should have. They were then put into the third inclosure as members of the final lamb band.

Under such a method of handling there is little doubt that the percentage of lambs saved is higher and that the lambs are better than when the ewes are lambed under the customary method on open range. There is no doubt that the expense of handling and the destruction of forage are very materially decreased. In this case the drop band is not excited in any way. They are free to scatter out and move about as they choose. When a ewe drops her lamb she falls away from the bunch and remains quietly with the lamb, properly drying it and caring for it. When the drop band is herded there is more or less noise and disturbance by dogs and herders. As a result, the ewe may rush off to the band, leaving the lamb uncared for. Then the herder intervenes and there is more excitement.

Under the range system of lambing a large percentage of loss is occasioned by "jamming" the young lambs to and from the corral each day in order to protect them from predatory animals. Many, perhaps, are unable to get in at all without help. The average herder will not take the trouble to carry them. Consequently they die or become the prey of coyotes. This loss, for the most part, is avoided under the pasturage system. They are put into a separate inclosure and remain constantly in the field, undisturbed except in special cases where a ewe will not own her lamb. The destruction of forage under this system will be small, because ewes with young lambs move very little unless molested, and, furthermore, they remain scattered out. The expense of handling is very small. In this case the 670 ewes were cared for by one boy, receiving a wage of $1 a day. Mr. Emmons occasionally made a personal inspection. With so little care the per cent loss was much less than it had been for any one of about ten years when the Emmons sheep were lambed on open range.

SUMMARY.

Up to this point the discussion has been merely a presentation of facts, with little attempt at definite conclusions. A summary may now be made in the form of conclusions arrived at by Mr. Emmons after ten years of experience with sheep on the open range, followed by two seasons' experience under the pasturage system. Mr. Emmons's conclusions are as follows:

(1) THE FENCE.

(*a*) The bottom barbed wire should be on the surface of the ground or beneath it everywhere.

(*b*) Greater care should be taken in filling all holes beneath the fence.

(*c*) There should be three instead of two barbed wires on top of the 26-inch woven wire.

(2) THE AREA.

(*a*) The carrying capacity of grazing land under this system is in the neighborhood of 100 per cent higher than under the customary system of herding in large bands.

(3) THE SHEEP.

(*a*) The percentage of lambs is higher than under the herding system.

(*b*) If properly cared for the sheep are much better.

(*c*) The loss is almost nothing.

(*d*) The expense of handling is materially decreased.

Mr. Emmons is now constructing an additional 5 miles of coyote-proof fence. Upon the area thus inclosed, approximately 800 acres of grazing land, he expects to graze 1,000 ewes and their lambs during at least five months of each year. As a result of his experience, Mr. Emmons believes that the pasturage system is the only way to handle sheep.

WILL THE PASTURAGE SYSTEM PAY?

The results already secured make it possible to offer suggestions toward placing the pasturage system on a practical basis.

The chief drawback to the system at the experimental pasture was the excessive cost of the fence. At the Emmons pasture this objection was done away with, but the fence constructed was not absolutely coyote-proof. To meet the objection of a cost not warranted by the industry and at the same time give a coyote-proof fence, the following specifications are offered.

Posts at intervals varying from 8 feet to 30 feet; light stays used every 10 feet where the posts are far apart.

On the surface of the ground a barbed wire, preferably a 4-point barb hog wire; 3 inches higher a 34-inch Elwood lawn fence, with a 4-inch triangular mesh; 5 inches above the woven wire a plain barbed wire; 6 inches higher a second barbed wire; and 8 inches above this a third barbed wire.

The size and number of posts, as well as the depth they are placed in the ground, may be governed by local conditions. Where ground is not rocky and timber is comparatively handy, it is advisable to make posts from 4 to 5 inches in thickness, and sharpen and drive them from 2 to 2½ feet into the ground. Where this method is applicable, they can be placed at short intervals with little expense.

Where timber is scarce, larger posts should be used at greater intervals, up to 30 or perhaps 40 feet, and set at least 2½ feet in the ground. In such cases, stays made from "edgings" or other cheap material should be used at intervals of 8 or 10 feet. In all instances great care should be taken in making the bottom of the fence tight. If properly done, there will be no trouble from coyotes and little or no repair work will be needed until the surface wire "rusts out." If half done, it will prove a continual source of annoyance. Great care should also be exercised in bracing, at intervals not greater than an eighth of a mile.

The final cost of this fence will, of course, depend upon local conditions, but an approximate estimate may be given that will serve as a working basis:

Elwood lawn fence, 34-inch, with 4-inch triangular mesh, at factory, about	per rod..	$0.36	
Freight to local railroad station not to exceed	do....	.14	
Four barbed wires, at $0.05 a rod, on local market	do....	.20	
Total cost for wire on local market	do....	.70	
Total cost for wire per mile on local market			$224
Posts and stays per rod		$0.15	
Posts and stays per mile			48
Cost of construction per mile			128
Total cost per mile			400

For many localities this estimate will be higher than the actual cost, but if the fence is to be substantially constructed the cost on most grazing lands will approach very closely $400 a mile.

Among the advantages of the pasturage system that justify this expenditure for fence construction are:

(1) Increased carrying capacity of 50 per cent over the customary herding system.

(2) Heavier sheep.

(3) Decrease from 3 per cent to one-half of 1 per cent in the loss.

(4) Less expense for handling.

(5) An increase in the lamb crop.

(6) Heavier and cleaner wool crop.

For the most part our grazing lands are so distributed that the spring, summer, fall, and winter ranges are separated from each other. This condition would necessitate the inclosing of four areas if the sheep are to be pastured during the entire year. For this reason and because the experimental data at hand were obtained from summer pasturing, the following estimate is based upon a pasture area of four sections (2,560 acres) as a unit area; 2,200 head of ewes and lambs as a unit band, and three months' summer grazing as the unit of time.

(1) The increase in carrying capacity is one-third of 2,200 head of sheep, 733 head. At the low rate of 2 cents a month this factor would amount to.. $44.00

(2) At the coyote-proof pasture the lambs gained 8.7 pounds over the best lambs of the same class when herded. At the low price of 3¼ cents a pound paid on the local market in 1907 this would amount to 28¼ cents a head. On 1,000 lambs..... 282.50

The ewes, too, either for the market or for the winter range, would be correspondingly better. We may safely estimate an increase of 10 cents a head for the three months on 1,200 head..... 120.00

(3) The decrease of 2½ per cent in loss of sheep would amount to 55 head. At $3 a head this would mean..... 165.00

(4) The decrease in expenditure for handling would amount, at least, to three-fourths the time of one camp man, his board, and horse labor, estimated at $45 a month for three months..... 135.00

(5) There is little or no question that there would be an increase in the lamb crop, even as a result of improved condition during the summer, but no definite data have been collected. In Australia, where the sheep are pastured the entire year, the owner estimates an increase of 10 per cent in lamb crop over the old system of herding.[a]

(6) That the wool crop will be heavier and cleaner will not be questioned, but the amount of increase is problematic so far as the present experiment is concerned. However, this factor in Australia is estimated to be as much as one-third increase in the weight of fleece, as well as a better quality of wool.[a]

Disregarding the increase in wool and the increase in lambs, we have a total increase in dollars and cents of..... 746.50

To inclose the area would require 8 miles of fence. Allowing $25 a year for maintenance and 8 per cent interest on all money invested, we would have:

Debit at close of first year—	
Eight miles of fence, at $400 a mile	$3,200.00
Interest at 8 per cent on $3,200	256.00
For maintenance	25.00
Total	3,481.00
Increase in profit each year due to the pasturage system	746.50
New principal at beginning of second year	2,734.50
Principal at close of fifth year	469.00
At the end of six years there would be a dividend of	215.00

In considering the above estimate it should be kept in mind that there has been no attempt to show what the profits of the sheep industry are. Each sheepman knows, much better than the author, whether or not his business is paying under the prevalent methods of herding on open range. The data here submitted are comparative and intended to show how the industry and the resulting profits might be increased by a change in the system of handling.

[a] Special Consular Reports, Australasian Sheep and Wool, 1892.

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